CHAPTER 5

ARRAYS AND STRINGS

After completing this lesson, you will be able to

- Explain the concept of array
- Know how array elements are arranged in memory
- Explain the terms related with array
- Explain how to define and initialize array
- Explain how to access and write at an index in array
- Explain how to transverse an array using all loop structures
- Using the sizeof() function to find the size of array
- Explain the concept of two dimensional array
- Explain how to define and initialize two dimensional array
- Explain how to access and write at an index in two dimensional array
- Explain what strings are
- Explain how to define string
- Explain the techniques of initializing string
- Explain the most commonly used string

INTRODUCTION

This unit describes a new type of data structure known as array, which provides a convenient way to manipulate a collection of same data type. Array is very commonly used in computer programming as it provides simple solutions to many problems when working with long lists of same data type such as numbers. For example, array can be used to sort a list of numbers or to find their total and average.

1.1 INTRODUCTION TO ARRAYS

Q1. Give a brief introduction to arrays in C++

Answer

Array

Array allows programmer to use a single variable name to represent a collection of same data type of data. This reduced the program size provides an easy way of handling list of numbers or strings. Array makes computer programming task simple and easy.

1.1.1 CONCEPT OF AN ARRAY

Q2. What is meant by an array? Explain its concept with the help of an example

Answer

Array

An array is a collection of same type elements stored in contiguous memory locations

Example

If we want of store marks of six subjects in computer memory, we have to declare six variables, one for each subject. Instead of using six variables, we can declare one array variable called marks that can store marks of six subjects. This array could be represented as shown in Fig 5.1

45
67
50
79
58
M

Structure of an array

Array consists of contiguous memory locations and each cell represents an element of the array. In the array named marks, each element of the array represent marks of a subject

Index

The number within the square brackets is called index and it used to access a specific element of the array. The first element of the array always has the index 0. Therefore, the index of the last element is one less than the size of the array. In the marks array, there are 6 elements so the index are from 0 to 5. Index of array is always an integer value.

1.1.2 DECLARING AN ARRAY

Q3. How do we declare an array in C++? State the method by which we can declare an array. Also give some examples of it

Answer

Declaring an Array

To declare an array in C++, the type of the elements, the name of array and the number of elements it is required to store need to be mentioned in the declaration statement

Syntax

The following is the general form of declaration of array

Datatype arrayname [arraysize];

Here, datatype is valid statement , arrayname is the name of the array which is a valid variable name and arraysize is enclosed within square brackets and it specifies the number of elements that can be stored in the array. This type of array is known as one dimensional array

Example

The following statement declares an array called marks of type integer that can store marks of six subjects

Int marks [6]:

The following are some more examples of array declaration

In a[10], b[15]

Float weight [8]:

Here, array a and b are integer arrays, a can store 10 values whereas b can store 15 values. Array weight declared as floating point array and It can store 8 weights

1.1.3 INITIALIZATION OF ARRAY

Q4. How do we initialize an array in C++? Explain with an example

ANSWER

Initialization of Array

An array can be initialized in declaration statement

Example

The following statement declared the marks array as integer of size 6 and assigns marks to each elements of the array

Int marks [6]= {45, 67, 50, 79, 58, 36}

When initializing an array, it is not necessary to mention the array size in the declaration statement since the compiler can find out the array size by counting the values in the curly brackets. Therefore, the above statement can also be written as

Int marks [ ] = {45, 67, 50, 79, 58, 36};

This statements is equal to the following statements:

Marks [0] = 45;

Marks [1] = 67;

Marks [2] = 50;

Marks [3] = 79;

Marks [4] = 58;

Marks [5] = 36;

1.1.4 USING ARRAYS IN PROGRAMS

Q5. Write a program that reads 5 integer values in array a and find their total and average

Answer

Program

```
#include<iostream>

#include<conio.h>

Void main()

{

Int a[5], k, total;

Float avg;

For (k=0;k<5;k++)

{

Cout<<"Enter a number"
```

```
Cin>a[k]
}
Total=0;
For (k=0;k<5;k++)
        Total = total +a[k]
 Avg=total/5;
Cout<<"\nTotal = "<<total<<End1;
Cout<<"Average= "<<avg<<end1;
Getch();
}
```

Explanation

When this program executed the statements in the first for loop are executed 5 times. In each iteration, a number is assigned to the array elements. The first number typed is stored in array elements a[0] the second in a[1] and so on. The second for loop adds all the numbers to the variable total, one by one. After finding the total average is calculated by dividing the total by 5

Output of the Program

The following is the execution of the program

```
Enter a number : 8
Enter a number: 13
Enter a number: 20
Enter a number: 5
Enter a number: 9
Total = 55
```

Average = 12

Q6. Write a program that reads ten integers and prints the biggest

Answer

Program

```
#include<iostream>

#include<conio.h>

Void main()

{

Int arr[10], k, max;

K=0;

Cout<<"Enter the numbers, one on each line:\n";

While (k<10)

{

Cin>>Arr[k];

K=k+1;

}

Max=arr[0];

K=1;

While (k<10)

        If(Ar[k]>max)

  Max=arr[k];

Cout<<"The biggest number is"<< max;
```

```
Getch():
}
```

Explanation

This program declares an integer array arr of size 10. The variable k is loop variable and the variable max used to store the biggest number

The first while loop stores 10 numbers in the array. The first element of the array is assigned to the variable max to assume that it is the biggest number. The second while loop compares the second element of the array with max. if it is bigger than max then max is assigned the second element. In this manner each element of the array from the second element to the last is compared with max. whenever an element is bigger than the current value of max, max is assigned the value of that element

Output of the Program

The following is the execution of the program

```
Enter the number, one on each line:
38
45
78
345
80
127
27
46
9
133
```

The biggest number is 345

Q7. Write a program that reads marks of n student and prints the number of students passed. The marks are in the range of 0 to 100 and passing marks are 33

Answer

Program

```
#include<iostream>
#include<conio.h>
Void main()
{
Int marks[50], n, k, pass:
Cout << "Enter the number of students (Max 50)":
Cin>>n:
Cout<< "Enter the marks, one on each line:\n:
For (k=0: k<n: k++)
Cin >> marks [k]
        Pass=0:
For (k=0: k<n: k++)
    If (marks [k]>32)
        Pass=pass+1:
Cout<< "Number of students passed= "<< pass:
Getch():
```

}

Explanation

1. The declarations statement declares array marks of 50 elements of type integers, n is the number of students k is loop variable and pass is a counter that stores the number of students passed in the examination
2. The first for loop will find the array marks with n marks. The user will enter n marks, one on each line one by one
3. When the program is executed, it prompts the user to enter the number of students and stores it in variables n. the array size is 50. Therefore, the number of students should not be more than 50
4. The last output statement will print the number of students passed in the examination

Output of the program

The following is the execution of the program

Enter the number of students (Max 50): 10

55

78

43

25

80

19

30

72

38

12

Number of students passed = 6

1.1.5 THE SIZEOF() FUNCTION

Q8. What is the size of() function? Explain its use by giving an example

Answer

Sizeof() Function

The sizeof() function provides the number of byes occupied to store values for data type named within the parenthesis. It is used to determine the amount of storage reserved for int, float, double char etc data types

Program

The following program prints the number of bytes occupied by int, float, double and char types

```
#include<iostream>
#include<conio.h>
Void main()
{
Cout<<"\nData Type                Bytes"
<<"\n---------------               ---------------"
<<"\nint                          "<<sizeof(int)
<<"\ndouble                       "<<size of (float)
<<"\nchar                         "<<size of (char)
<<End1:
Getch():
```

}

Output of the Program

The output of the program may differ depending on the compiler used. Most of the C++ compilers will produce the following output

Data type	bytes
Int	4
Float	4
Double	8
Char	1

The same function can also be used to find the number of bytes reserved for an array

Example (bytes reserved for an Array)

An array is declared as int a[10]. The number of bytes reserved for this array can be determined by writing the array name in the parenthesis as sizeof(a). this will return 40 because each statement of integer array occupies 4 bytes and there are 10 elements in the array. Similarly, the number of bytes occupied by arrays of other data types can be found.

1.1.6 INTRODUCTION TO TWO DIMENSIONAL ARRAYS

Q9. What is the use of two dimensional array? Explain it by giving an example

Answer

Two dimensional Array

A two dimensional array uses a single variable name to represent a collection of same type of data that is in the form of a table or matrix. It has two dimensional i.e. vertical and horizontal dimensions

Vertical & Horizontal Dimension

Vertical dimension represents row and horizontal dimension represents columns. Two dimensional array provides an easy way of handling data that is stored in the form of a table

Example

A two dimensional array a that has three rows and five columns is shown below

	Column 0	Column 1	Column 2	Column 3	Column 4
Row 0	A[0][1]	A[0][1]	A[0][1]	A[0][3]	A[0][4]
Row 1	A[1][0]	A[1][1]	A[1][3]	A[1][3]	A[1][4]
Row 2	A[2][0]	A[2][1]	A[2][2]	A[2][3]	A[2][4]

Explanation

Each cell in the table represents an element of the array in the form of a [row][col] where row and col written within square brackets and indices. The first index row represents the row number and second index col represents the column number that uniquely identify each element of a. the indices row and col are always integer values and start from zero. For example, a[1][3] will identify the element in second row and fourth column.

1.1.7 DEFINING AND INITIALIZING A TWO DIMESNIONAL ARRAY

Q10. How do we define a two dimensional array? State its general format and give some examples of defining a two dimensional array

Answer

Defining a Two Dimensional Array

To define a two dimensional array in C++ the types of the elements the name of the array and the number of elements it is required to store in rows and columns

General Form

The following is the general form of declaration of two dimensional array

Datatype arrayname[row size][column size];

Here database is a valid data type arrayname is the name of array and row size and column size enclosed within square brackets specify the number of rows and columns in the two dimensional array

Example 1

The following statement declares an array called a, that can store marks of 3 students of 5 tests

int a[3][5];

The row size which is 3 represents the number of students and column size which is 5 represents the number of tests. In C++ indices always start from zero. Therefore, the student number will be in the range of 0 to 2 and test number will be in the range of 0 to 4.

Q11. How do initialize a two dimensional array? State some examples of it

Answer

Initializing a two Dimensional Array

Just like one dimensional array, two dimensional array can also be initialized in declaration statement

Example

The following statement declares and initializes a two dimensional array called'a' that has 3 rows and 4 columns and assigns values to it

```
Int a[3][4]
{
        {45, 66, 39, 72}      // Elements of first row
        {87, 50, 56, 63}      // Elements of second row
        {44, 23, 53, 38}      // Elements of third row
};
```

Here nested braces are used for assigning values to each row of the array. This statement can be written on a single line s

```
Int a[3][4] = {{45, 66, 39, 72} {87, 50, 56, 63}, {44, 23, 58, 88}};
```

The above statement can also be written using a single set of braces as shown below

```
Int a[3][4] = {45, 66, 39, 72, 87, 50, 56, 63, 44, 23, 58, 88}'
```

The following statement initializes a two dimensional array of type float with 5 rows and 2 column

```
Float weight [5][2] =
        {3.40, 2.75} ,          // Elements of first row
        {4.75, 3.28},           //Elements of second row
        [8.10, 6.22},           // Elements of third row
        {4.71, 3.92},           // Elements of fourth row
        {1.43, 7.25}            // Elements of fifth row
};
```

1.1.8 ACCESSING AND FILLING A TWO DIMENSIONAL ARRAY

Q12. Explain the method to access and to fill a two dimensional array

Answer

Filling of a two dimensional Array

Data can be written in any element of a two dimensional array as if it was a normal variable by specifying the index of row and column

Example

The following assignment statement will store the value 15 in the element at row2 and column 4 of two dimensional array named k

```
K[1][3] = 15;
```

Accessing A two dimensional Array

Two dimensional arrays are generally accessed row by row using nested loop. Therefore, the row index is used as outer loop variable and column index as inner loop variable

Note: it may also be accessed column by column

Q13. Write a program that declares a two dimensional integer array of 3 rows and 4 column, initializes it with the data 30, 20, 55, 206, 78, 81, 25, 90, 3, 48, 67, 104 and finds the total of all the values

Answer

Program

```
#include<iostream>

#inclde<conio.h>

Void main()

{
```

```
Int i, j, total, k[3][4]= {{30, 20, 55, 206}, {78, 81, 25, 90},
{3, 48, 67, 104}};
Total =0;
For (i=0; i<3; i++)              // i represents row number of array k
    For (j=0; j<4; j++)          // j represents column number of array k
        Total = total + k[i[j];
Cout<<"total="<<total<<End1;
Getch();
}
```

Explanation

The variable total is initialized to 0. When the inner loop is executed for the first time, it finds the total of all the element of row 0 by adding the values 30, 20, 55 and 3206 one by one in variable total. The elements of row 1 and 2 are also added in total in the same way when the inner loop is executed for the second and third time.

Output of the Program

The output of the program is shown below

Total = 807

Q14. Write a program that multiply each element of the array by 2 that have 3 rows and 4 columns and display it in the form of matrix. The array is initialized to data values from 1 to 12 with 3 rows and 4 columns

Answer

Program

```
#include<iostream.h>
#include<conio.h>
#include<iomanip.h>
Void main()
{
Int i, j, k [3][4] = {{1, 2, 3, 4}. {5, 6, 7, 8}, {9, 10, 11, 12}};
// Each set of curly brackets initializes 4 values of each row
For (1-0, i<3: i++)          // index I represents row number
  For (j=0;j<4;j++)          //index j represents column number
        Cout<<setwidth (5)<<k[i][j]*2:
//Multiply each element with 2 and output
Cout<<          // After outputting a row move pointer to next row
Getch():
}
```

Explanation

In this program the setw() function is used to print each data value right justified in a width of 5. This will properly align th data in the output

Output of the Program

The output of the program is given below

```
2     4     6     8
10    12    14    16
18    20    22    24
```

5.3 STRING

5.3.1 INTRODUCTION

Q16. Give a brief introduction to strings in C++>

Answer

String

String is a sequence of characters. In C++ character string is stored in a one dimensional array of char type. Each element of character string holds one character

Uses of string

String is most commonly used item is computer programming to represent name, address, object, book, title etc.

Null Character

All the strings end with a special character known as null character and it is represented by 10. The null character is automatically appetided at the end of string

1.3.2 A STRING

Q17. Write down the method to define string in C++. Explain by giving an example

Answer

Define a string

To define string in C++ the data type char the name of string and the number of characters it is required to store is mentioned in the declaration statement

General Form

The following is the general form of declaration statement

Char stringname [stringsize];

Explanation

The char keyword lets the compiler know that a variable of type character is declared. The string name is the name of the string variable. It follows the same rules of other type of variables. The stringsize enclosed within the square brackets specifies the number of characters that can be stored in the string

Note: since the null character is appended at the end of string. If a string has n character then the stringsize should be at least n+1

Example 1

The following statement declares a string called weekday that can hold maximum 10 characters including some for the null character

Char weekday [10]';

Example 2

The following statement declares a string called **student name** that can hold 20 character including one for the null character

Char student name [20];

Q18. State the method to initializing strings in C++.

Answer

Initializing Strings

Just like arrays of integer and floating point numbers string arrays can also be initialized in the declaration statement

Example 1

The following statement declares and initialize the string variable weekday to Sunday

Char weekday[10] = {'S', 'u', 'n', 'd', á', 'y'}

Representation of string in computer memory

The following diagram shows how the string variable weekday is represented in computer memory

Index	0	1	2	3	4	5	6	7	8	9
Variable	S	u	n	d	a	y	\0			

The index starts from zero. The compiler automatically places the null character (\0) after the last character. The remaining three characters are not defined

Second Method to Initialize String Variable

Another way used to initialize a string variable is to type the contents within the curly brackets but without mentioning its size by leaving the square brackets empty.

Example

Char city[]= "Karachi":

In this statement city is a string variable that holds 8 characters. Although "Karachi" has 7 character the null character is automatically appended to the end of the string which makes it a string of size 8.

1.4 COMMONLY USED STRING FUNCTIONS

Q19. Which header files is used for string? Describe the most commonly used string functions

Answer

Header file for String

To use strings in computer program. It is essential to learn how string functions are used. The header file <String.h> is used when string functions are used in the program. C++ supports a large number of string handling functions in the standard library <String.h>

Commonly used String Functions

The most commonly used string functions are described as follows

1. Cin get() function
2. Strcpy () function
3. Strcat() function
4. Strcmp() function
5. Strlen) function

1. **Cin get() function**

   This function is used to read a string from the keyboard that may contain blank spaces

   General form

   The general form of cin get() function is

   Cin.get(strvar, strsize):

   It has two arguments. First argument strvar is the name of the string variable and the second argument strsize is the maximum size of the string or character array

Program- Demonstrates the use of Cin.get() function

```
#include<iostream.h>
#include<conio.h>
#include<String.h>     // header file to use string functions
Void main()
{
```

```
Char str[50]:

Cout<<"Enter a string:'

Cin.get (str 50)

Cout<< "You types <<str<<End1;

Getch():
```

Output of the Program

The following is the execution of the program

Enter a string: Information string

You types: information technology

String Read by cin statement

A string can also be read using cin statement but it has some limitation. This is shown in the following program

Program

```
#include<iostream.h>

#include<conio.h>

Void main()

{

Char str[50];

Cout<<"Enter a string";

Cin>>str;

Cout<<"You typed"<<str<<End1;

Getch():

}
```

Output of the program

The following is the execution of the program

Enter a string Information technology

You typed information

Explanation

In the output, only the first word information is printed. The reason for this is that the cin statement considers a space as terminating character. The cin statement reads strings that consist of a single word. Anything typed after a space is ignored.

2. **Strcpy() Function**

   The Strcpy () function is used to copy contents of a string variable or string constant to another string variable

General Form

The general form of Strcpy () function is

Strcpy (string 1, string 2):

It has two arguments string 1 and string 2 which are string variables. When It is executed contents of string 1 will be copied to string 2

Example

Char string1 [10] = "ISLAMABAD"

String2 [10], string3 [10]:

Strcpy (string2, string1):

Cout<<"sring2= "<<string2<<End1:

Strcpy (string3, "Pakistan"

Cout<<"string 3= "<<string3<<end1;

Output of the Program

The output of the above code will be

string1=ISLAMABAD

string3=PAKISTAN

3. Strcat() Function

The Strcat () function is used for concentration or joining of two string

General Form

The general form of Strcat () function is

Strcat (string1, string2):

When this function is executed it will append (concatenate) string 2 onto the end of string 1

Example

Charstring1 [10], string2 10];

Strcpy (string1, "HOME"):

Strcpy (string2, "WORK"):

Strcat (String1, string2):

Cout<<"string1 =", <<string1<<End1:

Explanation

When the above code is executed, the first Strcpy () function will copy the string "HOME" to string variable string1 and the second Strcpy() function will copy the string "WORK" to string variable string2. The Strcat() function will append the string 2 onto the end of string 1.

Output of the Example

The output of the above code will be

String1 = HOMEWORK

4. Strlen() function

The Strlen() function is used to return the length (the number of characters) of a string

General form

The general form of Strlen() function is

Strlen(string):

Example

Here string is a string variable. For example

Char string "COMPUTER";

Cout <<"The number of characters in the string is

<<Strlen(string1 << end1;

Output of the example

The output of the above code will be

The number of character in the string is 8

Program- Demonstrates the use of Strlen() function

```
#include<iostream.h>

#include<conio.h>

#include<string.h>

Void main()

{

Char city1= "LAHORE", city2= "ISLAMABAD", city 3= "KARACHI";

Cout<< characters in city 1 are: "<<Strlen(city1)<<End1;

Cout<<"Characters in city 2 are" <<Strlen(city2)<<end1;

Getch();
```

}

Output of the Program

The output of the program will be

Character in city 1 are: 6

Character is city 2 are: 9

Characters in city 3 are: 7

5. **Strcmp() function**

   The Strcmp() function compares two strings and returns an integer value based on the result of comparison. This comparison is based on ASCII codes of characters

   General form

   The general form of Strcmp() function is

   Strcmp(string1, string2):

Explanation

When it is executed it will compare the first characters of string 1 and string 2. If they are the same, it will compare the second pair of characters. The comparison will continue until the characters differ or a terminating null character is reached. During comparison A is considered less than B and B is considered less than C and so on

The function will return the following integer values based on the result of comparison

1. It will return 0 if string1 and string2 are the same
2. It will return 1 if string1 is greater than string 1
3. It will return -1 if string1 is less than string 2

Program – demonstrates the use of strcmp( ) function

```
#include <iostream.h>
```

```
#include <conio.h>
#include <string.h>
Void main ( )
{
Char string1"MANGO", string2="MANGO", string3="POTATO",
string4="ORANGE":
Int x, y, z:
X=strcmp(string1, string2):
Cout<<"string1 and string2 are equal, x="<<x<<end1;
Y=strcmp(string3, string1):
Cout<<"string3 is greater than string1, y="<<y<<end1;
Z=strcmp(string1, string4):
Cout<<"string1 is less than string4, z="<<z<<end1;
Getch( )I
}
```

Output of the program

The output of the program will be

String1 and string2 are equal

String3 is greater than string1

String1 is less than string4

Key Points

- An array is a collection of same type of elements stored in contiguous memory location
- A two dimensional array uses a single variable name to represent a collection of same type of data that is in the form of a table or matrix
- The Cin.get() function is used to read a string from the keyboard that may contain blank spaces
- The Strcat() function is used to append a string onto the end of another string
- The Strlen() function is used to return the length (the number of characters) of a string
- The Strcmp() function compares two string and returns an integer value based on the result of comparison